936-91 Is Exercise Thallium-201 Imaging Helpful in Risk Stratifying Patients with Cardiac Transplant Coronary Artery Disease?

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Prior studies have shown that patients with normal exercise SPECT thallium (Tl) scans have a favorable prognosis despite the angiographic presence of CAD. Patients with cardiac transplant (Tx) CAD have a high incidence of adverse events including silent MI and sudden death. However given the limited availability of donor hearts, and the lower survival after the second transplant, a technique to risk stratify patients with Tx CAD would be clinically useful and cost-effective. Thirteen patients (mean post-Tx time 40 mo) with angiographic CAD underwent exercise and 4 hr redistribution SPECT Tl imaging. Ten patients had epicardial (≥50% diameter reduction) and small vessel disease, two had isolated small vessel disease, and one had isolated epicardial disease. SPECT imaging revealed fixed or reversible defects in 10/13 (77%) patients, 3 patients had normal scans. There was no significant difference in mets achieved during exercise, nor in the extent of CAD between the groups. During a mean follow-up of 20 mo, 8/10 (80%) patients with positive Tl scans had graft failure or death vs 0/3 (0%) patients with negative Tl scans ($p < 0.05$, Kaplan-Meier survival analysis). This preliminary data suggest that SPECT Tl imaging may be of value in risk stratifying patients with Tx CAD.

937 New Approaches to Dobutamine Stress Echocardiography

Tuesday, March 21, 1995, 9:00 a.m.–11:00 a.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: 9:00 a.m.–10:00 a.m.

937-1 Color Doppler M-Mode Assessment of Flow Velocity Propagation During Early Filling; A Useful Adjunct to Wall Motion Analysis During Dobutamine Stress Echocardiography

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Flow velocity propagation (FVP) during early left ventricular (LV) filling correlates with LV relaxation and has been shown to be a sensitive index of ischemia during angioplasty. To test the ability of color Doppler M-mode to detect ischemia during dobutamine (Db) stress echo we prospectively evaluated 26 pts (13 females, age 61 ± 13 y).

Methods: FVP was evaluated in digitally acquired recordings of color Doppler M-mode as the slope of the color/non-color (black to red) transition of transmitral flow during early filling, at rest and with each increment of Db. An abnormal FVP response was defined by reduction of the slope with increase of Db dose. Digitized echo images were compared at rest and during stress to identify the presence of new or worsening wall motion abnormalities (WMA). Nine pts (group A) were designated as having coronary disease on the basis of WMA, typical angina and ST depression, and abnormal coronary anatomy. Seventeen pts (group B) without WMA in the presence of normal coronary anatomy or low (<10%) pretest probability of disease were designated as having no coronary disease.

Results: All pts in group A developed an abnormal FVP response to Db stress (sensitivity 100%). In group B, 7 of 17 pts without coronary disease presented an abnormal response as evaluated by FVP (specificity 59%). Of the false positive group, 86% had echocardiographic evidence of left ventricular hypertrophy, with a strain pattern by EKG, compared with only 30% in the true negative group ($p < 0.001$).

Conclusions: i) Color Doppler M-mode is very sensitive to ischemia during dobutamine stress echo, ii) Other conditions as left ventricular hypertrophy with strain pattern can produce the same response, iii) Color Doppler M-mode evaluation of diastolic function may be a useful tool during dobutamine stress echo.

937-2 Safety and Efficacy of QW3600 (EchoGen®) in Producing LV Opacification During Stress Echocardiography in Normals

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QW 3600 (EchoGen®) (EG) is a new ultrasonic contrast agent which produces intense LV cavity and even myocardial opacification following IV injection in animals. However, no data exists regarding the potential of this agent to be used in conjunction with stress echo in humans. Therefore, in 17 normals we compared the results of injecting equal volumes of normal saline and progressive doses of EG: 0.02 cc/kg (5 pts), 0.05 cc/kg (4), and 0.1 cc/kg (8) during stress echo performed to 85% of maximal heart rate. Echo was performed in apical 4 chamber view, and LV contrast opacification was assessed qualitatively (1+ weak and incomplete, 2+ complete cavity, 3+ dense and complete) and by videodensitometry (0.3 cm^2) region of interest in mid cavity. All subjects tolerated the injections well without adverse events. No significant changes were observed in pulse oximetry, the ECG, or 25 laboratory studies. We analyzed the maximal change (Δ) in systolic (S) and diastolic (D) pressure (mmHg) and heart rate (HR) and peak videointensity (PVI) from baseline to post exertion *following* the injection of either saline or EG (Table, all p = NS for saline vs EG except PVI).

Dose	Saline				EG			
	ΔHR	ΔSBP	ΔDBP	PVI	ΔHR	ΔSBP	ΔDBP	PVI
0.02	48	43	18	13	42	49	17	28
0.05	37	35	16	11	43	43	21	42
0.1	37	40	19	10	37	44	19	62

LV opacification was absent with saline, was inconsistent at 0.02 and 0.05 cc/kg doses, but was ≥ 2+ in all but one 0.1 cc/kg administration (mean 2.4). Peak LV videointensity after EG was 62 for 0.1 cc/kg. Thus, EchoGen® is a new contrast agent which is well tolerated when used with stress echo in normals and results in complete LV opacification at a dose of 0.1 cc/kg. EchoGen® should prove to be a useful adjunct to clinical stress echo.

937-3 Sonicated Albumin in Exercise Echocardiography: Technique and Feasibility of a Novel Approach to Enhance Endocardial Border Visualization

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Exercise echocardiography (EE), used to assess for myocardial ischemia, is limited mainly by suboptimal endocardial visualization in the immediate post-exercise (Post-Ex) images. Enhancement of LV cavity can be obtained following an intravenous injection of sonicated albumin (Albunex®), but its use in EE has not been reported. To determine the feasibility of Albunex® contrast EE and an optimum dosing technique, 15 healthy volunteers (5 men and 10 women, age 40 ± 7 years) underwent a routine EE and a contrast EE on the same day. Albunex® was injected intravenously and continuously until contrast first appeared in LV. Echo images from the apical four (A-4) and two (A-2) chamber views were obtained at rest and Post-Ex. There was no difference in the time to image acquisition between the two EE. Albunex® provided full LV opacification in 14 of 15 subjects both at rest and Post-ex. The overall percentage of endocardial visualization increased from 86% without to 91% with contrast enhancement ($p < 0.01$). Similar increases were seen in Post-Ex A-4 (86% vs 97%, $p < 0.01$) and Post-Ex A-2 (81% vs 88%, p = NS). Time to initial contrast in LV (transit time) and volume at rest and Post-Ex were compared:

Variable	Rest A-4	Post-Ex A-4	Rest A-2	Post-Ex A-2
Time (sec)	9.7	5.0	9.3	5.2
Volume (ml)	12.1	9.6	11.8	8.4

$p < 0.01$ between all rest and Post-Ex values

Transit time ($r = 0.72$) and volume required ($r = 0.57$) correlated with cardiac output but not with body size.

Conclusion: Our method of Albunex® EE proves to be feasible in normal subjects and results in full LV opacification with a high degree of endocardial visualization in most subjects. Both the volume of Albunex® and the transit time are reduced Post-Ex. Albunex® appears to have a useful role in EE.

937-4 Combined Use of Dobutamine Stress Echocardiography and Myocardial Contrast Echocardiography

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Combined use of Dobutamine stress Echocardiography (DSE) and Myocardial contrast echocardiography (MCE) offers the unique possibility to study myocardial function and perfusion.

Aim of the study: To define the characteristics of collateralized myocardium (CM) in comparison to normally perfused myocardium (NM) using DSE and MCE.

Methods: In 14 patients (pts) (10 males, 4 females) with single vessel total occlusion of one major epicardial coronary artery and intercoronary collaterals (Rentrop3) DSE was performed together with MCE. Wall motion score index (WMSI) was calculated. Sonicated iopamidol was injected into the right and left coronary artery with simultaneous twodimensional Echo imaging of all standard apical views in every patient. Videodensitometry of contrast en-

hanced (C) images was used to calculate Intensity (I) increase in gray scale units (U). The same myocardial segments were analyzed to define WMS and U for CM and NM for the presence (+) or absence (−) of wall motion abnormalities.

	CM		NM
	+	−	
WMSI rest	2.1 ± 0.39	1 ± 0.1*	1.10 ± 0.09*
stress	2.5 ± 0.61	1.42 ± 0.75**	1.19 ± 0.48
MCE (I)	21.5 ± 9.4	40.9 ± 17.6*	48.0 ± 17.6**

*p < 0.05 + vs −, **p < 0.05 CM vs NM

Conclusion: Despite the presence of large intercoronary collaterals CM has decreased myocardial perfusion which becomes worse if wall motion abnormalities are present. Combined use of DSE and MCE provides a unique method to define the characteristics of the myocardium by its contractile function and perfusion.

937-5 Basal Post-Systolic Shortening Predicts the Response of Hypo-Akinetic Myocardium to Low-Dose Dobutamine in Chronic Coronary Artery Disease Patients

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Currently adopted criteria for the evaluation of dobutamine echo-stress (DSE) take into account the amplitude of endocardial motion and wall thickening. The experimental evidence, however, indicates that an asynchronous contraction is a constant hallmark of myocardial ischemia; post-systolic shortening (PSS) has commonly been found in prolonged ischemia and in post-ischemic contractile depression. As far as we know, the synchrony of contraction has not been considered in clinical studies on the response of ischemic myocardium to dobutamine and the presence of PSS in basal echocardiograms of CAD patients has not been related to the presence of viable myocardium at 201-Tl redistribution studies. In this work we selected 21 pts (19 male, aged 44 to 72 yrs, mean 59), out of a series of 140 submitted to DSE, according to the following criteria: 1. presence of hypo-akinetic regions supplied by critically stenosed coronary vessels; 2. feasibility of M-mode tracings at the basal and mid level of anteroseptal, anterior, posterior and inferior segments; 3. recording of PSS in at least one segment; 4. 201-Tl SPECT performed using stress-rest and rest-redistribution protocols. The examinations were performed within 15 days from coronary arteriography, in the absence of any clinical event suggesting acute ischemia. In all pts, 8 segments were analyzed for the presence of PSS at rest, the regression of hypo-akinesia at DSE and the presence and reversibility of perfusion defects at 201-Tl-SPECT. Results are summarized as follows:

	Dobutamine normalization			201-Tl SPECT			
	*	No	Yes	Total	Perfused	No-R	R	Total
PSS								
*	90			90	59	15	16	90
Absent		30	2	32	8	20	5	32
Present		1	45	46	7	22	17	44
Cramer's V		0.96				0.37		
Contingency Coefficient		0.80				0.46		

* = normokinesis in basal condition, No-R = not reversible defect, R = reversible defect

Our results, in keeping with the experimental observations, indicate that hypo-akinetic segments showing PSS at rest have a contractile reserve at low-dose DES, suggesting the presence of ischemic, but viable myocardium.

937-6 Biphasic Response to Dobutamine Stimulation of Asynergic Myocardial Segments — An Uncommon Phenomenon

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To evaluate the incidence of biphasic wall motion response and the relationship between dobutamine augmentation of asynergic segments and coronary stenosis severity in chronic coronary artery disease, we studied 9 pts (age 58 ± 7 yrs; 7 male) with dobutamine echocardiography and quantitative coronary angiography. Wall motion was assessed in a 16-segment model at 5 and 10 mcg/kg/min and at the highest achievable dosage (34 ± 6.8 mcg/kg/min). Analysis was possible in 140 (97%) of 144 segments. Abnormal wall motion at rest was found in 105 segments (75%), 36 were hypokinetic and 69 akinetic. Overall, 41 segments (39%) improved during dobutamine infusion (80% improved at 5 to 10 mcg/kg/min and 20% at higher dosage). Improvement was found in 86% of hypokinetic segments and 15% of akinetic segments. Thirty-three segments with improvement were supplied by vessels with ≥65% diameter stenoses (mean 82 ± 14%). Only 3 of these segments (9%) supplied by vessels with significant stenoses showed a biphasic response to dobutamine with worsening of wall motion at maximal dosage, whereas improvement persisted in the remaining 30 segments despite comparable stenosis severity. Twenty percent of the improving segments were supplied by vessels without significant stenoses. (These segments were hypokinetic at rest and wall motion abnormality was probably not due to ischemia).

Thus, wall motion improvement of hibernating myocardium during low dose dobutamine surprisingly persists in the majority of segments at higher dosages normally used to provoke ischemia although these segments are generally supplied by vessels with severe stenoses. The expected biphasic response to dobutamine seems to be uncommon and not related to stenosis severity.

937-7 Is Lack of Hyperkinesis a "Normal Variant" During Dobutamine Stress? A Quantitative Two-Dimensional Echocardiographic Study

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Inotropic stimulation with simultaneous changes in heart rate and loading conditions can induce even in normal hearts a heterogeneity in wall motion and thickening, possibly mimicking an "ischemic" regional hypokinesia or lack of hyperkinesia during stress echocardiography. To describe in a quantitative fashion the physiologic contractile response of different left ventricular regions following dobutamine (dob) infusion, 223 in-hospital patients who underwent dobutamine stress echocardiography and coronary angiography were initially considered. Of these 223 patients, 18 had angiographically normal coronary arteries, normal resting function, negative ergonovine and exercise stress test, and negative Dob-stress echo; of the 18, only in 11 patients (6 females, age = 56 ± 10 years) it was possible to obtain quantitative measurements of the middle segments of the inferior, anterior, lateral, and septal wall (apical 4- and 2-chamber view). 2D-Echo measurements of wall thickness were obtained at end-diastolic (onset of q wave) and end-systolic phases, both at baseline (rest) and at peak dob (40 μg/min/kg plus atropine). During stress, % systolic thickening (%STh) decreased in the inferior wall (rest = 73 ± 24 vs dob = 50 ± 9 %; p < 0.01), whereas it increased to a variable extent in the other regions, i. e. septal (rest = 46 ± 17 vs dob = 68 ± 13%, p < 0.01), anterior (rest 62 ± 19 vs dob = 69 ± 11%, p = ns), and lateral wall (rest = 48 ± 16 vs dob = 61 ± 18%, p = ns). The decrease in %STh of the inferior wall was inversely correlated with the increase in end-diastolic wall thickness (r = −0.75; p < 0.01), but neither with heart rate (r = 0.15; p = ns) nor with systolic blood pressure changes (r = 0.05; p = ns).

In conclusion, heterogeneity of left ventricular wall thickening can be induced or magnified by dobutamine infusion even in subjects without coronary artery disease, with the inferior wall showing a lack of hyperkinesia, or even a relative hypokinesia, in comparison with other myocardial regions. Caution in aggressive dobutamine stress echocardiography reading, especially in the inferior wall, might be warranted.

938 New Methods to Assess Myocardial Viability

Tuesday, March 21, 1995, 9:00 a.m.–11:00 a.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: 10:00 a.m.–11:00 a.m.

938-54 Echocardiographic Assessment of Myocardial Viability After Reperfusion: Contractile or Microvascular Reserve, which is Better?

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The non-infarcted region within the reperfused myocardium has both contractile and microvascular reserve, which form the basis for the assessment of myocardial viability: the former for dobutamine echocardiography (DE) and the latter for myocardial contrast echocardiography (MCE). The purpose of this study was to evaluate which of the two, DE or MCE, is better for the assessment of myocardial viability after reperfusion. Accordingly, 15 open-chest dogs underwent 3–6 hr of coronary occlusion followed by reperfusion. DE (using 15 μg/kg/min of dobutamine) and MCE (using an aortic root injection of 1–5 ml of Albunex®) were performed during reperfusion both in the absence and presence of a critical stenosis supplying the reperfused myocardium. Infarct size was measured using triphenyltetrazolium chloride (TTC).

During reperfusion, in the absence of dobutamine, there was a poor cor-